ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

Astron. Astrophys. Suppl. Ser. **132**, 195–196 (1998)

Observations of the Sun with the astrolabe of Santiago: 1995-1997

F. Noël

Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile

Received March 2; accepted April 14, 1998

Abstract. Observations of the Sun with a modified Danjon astrolabe at 30° and 60° zenith distances are beeing carried out since 1990 at Santiago, Chile. Here are presented the results in right ascension, parameter Y and apparent semidiameter obtained during the period 1995-1997. These results and those obtained in former years are available in electronic form[1]. The differences astrolabe minus ephemeris in alpha and semidiameter are briefly discussed.

Key words: astrometry — Sun: general

1. Introduction

After prior modifications the Danjon astrolabe is a reliable instrument for solar observations (Laclare 1983). A program of astrometric observations of the Sun at 30° and 60° zenith distances is in progress since 1990 with the astrolabe of the National Astronomical Observatory of Cerro Calán at Santiago, Chile. This program is a contribution to the research of the orbital elements of the Earth-Moon system. However, since the results of the observations are sensible to the adopted semidiameter of the Sun, eventual variations of the apparent solar radius can be also disclosed (Noël 1997). The modifications introduced in the Danjon astrolabe of Santiago, as well as the program of solar observations and the reduction method, were described by Chollet & Noël (1993). All the individual results of the observations made since the beginning of the solar program in 1990, have been published elsewhere and are available in electronic form (Noël 1993, 1994, 1995). With this paper the data set of solar observations results of Santiago is updated with the results obtained during the period 1995-1997.

Send offprint requests to: F. Noël

[1] Tables 2 and 3 are only available in electronic form via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/Abstract.html

2. Observations

All the observations were made visually by the author of this paper and each one consists in timing the transit of one border of the Sun through the corresponding small circle of fix altitude. During one day one observes the transits of the upper and lower border at the east, and the transits of the lower and upper border at the west. The fix zenith distances of 30° and 60° are defined by means of CERVIT reflecting prism that are interchangeable rather easily in a few minutes without further adjustment of the telescope. Therefore, observations at at both zenith distances are possible during the same day. According to the latitude of the astrolabe ($-33°23'56''.976$) the Sun can be observed during the whole year at 60° zenith distance and from October 6 untill March 7 at 30°.

The transit times are registered by a PC microcomputer adapted as chronograph with $0^{\mathrm{s}}.0001$ resolution. The precise UTC reference is provided by a GPS timer receiver at the astrolabe pavillion, or alternatively, by a Cesium atomic standard of the time service of Cerro Calán Observatory.

3. Reductions and results

All the observations were reduced using the DE200/LE200 ephemeris of the Sun. The orientation of the local reference frame is obtained by means of the Earth rotation parameters (polar coordinates and UT1-UTC) interpolated from Bulletins B published by the Central Bureau of the International Earth Rotation Service (IERS). A detailed description of the reduction method applied at Santiago for solar observations was given by Chollet & Noël (1993).

The average annual values of the differences in right ascension (astrolabe-ephemeris) and those of the observed Sun semidiameter reduced to the astronomical unit, obtained during the period 1995-1997 and during former years of the solar program are given in Table 1.

The individuals results of the observations at 30° and 60° for the period 1995-1997 are reported in Tables 2 and 3

Table 1. Yearly mean values in right ascension (observed-ephemeris) and solar semidiameter, and their mean errors, derived from astrolabe observations of the Sun. n is the number of individual measurements involved

Year	Alpha (O−E)		Semidiameter		n
1990	$0^{\rm s}.043$ ±	$0^{\rm s}.009$	$961''.05$ ±	$0''.07$	62
1991	0.024	0.006	960.78	0.06	52
1992	0.018	0.005	960.62	0.06	80
1993	0.029	0.003	960.49	0.03	146
1994	0.042	0.004	960.24	0.03	124
1995	0.063	0.004	960.08	0.03	115
1996	0.080	0.004	959.85	0.03	123
1997	0.052	0.004	960.00	0.03	120

respectively (accesible only in electronic form) with results of former observational periods. The following information is available from these tables:

- Year, month, day of the observation,
- The modified julian day,
- Zenith distance residual given by the observation of the Sun east upper border, east lower border, west lower border and west upper border,
- Right ascension (observed-ephemeris) with its standard deviation,
- $Y = {\rm d}z + {\rm d}\delta \cos {\rm S}$, where ${\rm d}z$ = zenith distance (observed-computed), ${\rm d}\delta$ = declination (observed-ephemeris) and S is the Sun's paralactic angle (Chollet & Noël 1993),
- Sun's apparent semidiameter (observed-ephemeris) with its standard deviation,
- Sun'a apparent semidiameter reduced to the geocenter and to the astronomical unit.

4. Discussion

The annual mean right ascension differences in the sense observed- ephemeris, presented in Table 1, show a positive and significative general trend throughout all the observational period. As it is stated above, the orientation of the local reference of the astrolabe is based on the Earth rotation parameters provided by IERS which are refered to the International Celestial Reference System (ICRS) (Arias et al. 1995). Beside some eventual systematic effect of instrumental and/or personal bias origin, the systematic differences in right ascension of Table 1 could be partially due to an offset of the ICRS equinox and the dinamical equinox of the DE200/LE200 solar ephemeris. It has been found that observed positions of the Sun in the FK5 system, show also a positive trend for the differences in right ascension FK5-DE200/LE200 (Kolesnik 1995, Da Rocha Poppe 1998). This might be a confirmation of our results if one considers that the ICRS origin of right ascension is consistent with the FK5 origin (Arias et al. 1995). According to Hohenkerk et al. (1992) an effort was made to make the origin of DE200/LE200 ephemerides agree with the FK5 equinox, but it was recognized that there is some difference, which will be determined more accurately with time.

The annual mean values of the solar semidiameter of Table 1 represent the averages of the results of the east and west observations at 30° and 60° zenith distances. The dispersion of the semidiameter measurements derived separately from the east and west observations, is $0''.42$ and $0''.43$ respectively for 30°, and $0''.55$ and $0''.45$ for 60°. The higher dispersion of the east results at 60° is probably due to the local topography which should affect more the observations made at larger zenith distances. The high mountains of Los Andes range are at the east and rather close to Cerro Calán Observatory.

According to Table 1, a systematic decrease of the semidiameter is observed throughout the observational period except for 1997. This variation has a similar trend as the variation of sunspot number during the same period. An eventual solar origin of the Sun semidiameter variations observed with the astrolabe of Santiago is under research and for a preliminary discussion see Noël (1997).

Acknowledgements. The project of the Danjon astrolabe at Santiago is a joint research program between the European Southern Observatory (ESO) and Universidad de Chile. The solar program of Santiago is partially supported by Fondo Nacional de Ciencia y Tecnología (FONDECYT), Santiago, Chile, under research project No. 1970312.

References

Arias E.F., Charlot P., Feissel M., Lestrade J.-F., 1995, A&A 303, 604
Chollet F., Noël F., 1993, A&A 276, 655
Da Rocha Poppe P.C., 1998, Sc. Dr. Thesis, University of Sao Paulo, Brasil
Hohenkerk C.Y., Yallop B.D., Smith C.A., Sinclair A.T., 1992, in Celestial Reference Systems, Explanatory Supplement to the Astronomical Almanac, Seidelmann P.K. (ed.). University Science Books, California, U.S.A, p. 97
Kolesnik Y.B., 1995, A&A 294, 874
Laclare F., 1983, A&A 125, 200
Noël F., 1993, A&AS 102, 11
Noël F., 1994, A&AS 106, 327
Noël F., 1995, A&AS 113, 131
Noël F., 1997, A&A 325, 825